Intelligent Metal Forming

Computer design and fabrication of metal parts using sheet and bulk forming processes

For decades, we have been involved in very low-volume design and manufacture of metal parts using sheet and bulk forming processes. Using advanced computer codes in combination with our CAD-to-mesh capability, lithography and rapid prototyping, and preproduction precision manufacturing facilities, Lawrence Livermore provides a complete capability in "intelligent metal forming." We maintain active efforts in forging, hydroforming, and superplastic forming and joining processes for highly engineered multi-sheet processes suitable for aerospace, automotive, and industrial applications. Our expertise in metal-forming capabilities can also mean manufacturing cost savings by providing technologies to reduce material cost and minimize scrap.

APPLICATIONS

- *Metal parts design*
- *Sheet and bulk metal forming*
- *Metal failure prediction and testing*

Computer design

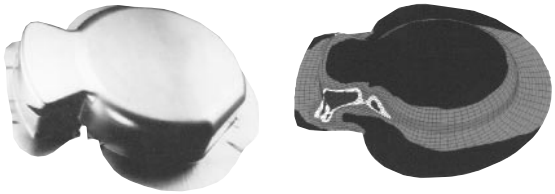
The metal-part design process begins with full three-dimensional, nonlinear finite-element analyses using the Lab-developed NIKE and DYNA computer codes. The TOPAZ code is used for thermal analysis, and the ALE code is used for problems with extreme mesh contortions (redundant work in extrusions). In addition, we can create coupled versions of these codes for specific uses.

Bulk forming experience

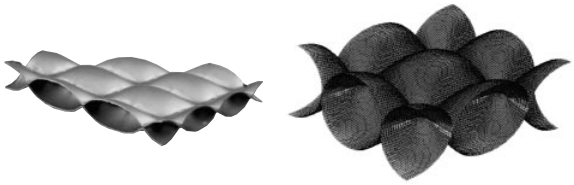
Our expertise includes metallurgy and process design for rolling, forging, extrusion, and the high energy-rate forge process with alloys of aluminum and iron bases, as well as others. We use finite-element calculations of bulk metal flow to predict grain flow, redundant work, and residual stress, and have incorporated a pressure-augmented, forming-limit diagram capability for analysis of failure due to the multi-axial strain field resulting from deformation.

Sheet-metal hydroforming

Hydroforming is often used for low-volume sheet-metal components. We employ both analytical calculations and the NIKE and DYNA codes for predictions of buckling and tearing. In addition to uni-axial and tension/torsion mechanical tests, we have facilities for testing limiting dome height, bulge, and plane strain.



Aluminum hydroformed sheet component and computer analysis.



Sandwich structure process using superplastic forming metal.

Superplastic sandwich structures

Process design for generating high-quality sandwich structures is a focus of both the Laboratory, the Department of Energy's production facilities, and our industrial partners. High-reliability parts with new alloys are now under study. Our facilities and expertise in solid-state bonding, laser and electron-beam welding, joining metallurgy, and the finite-element analysis of these coupled thermal-mechanical problems leads to a complete resource capability for design and prototype production.

Availability: Our metal-forming resources are available now, with both public and protected versions of our computer codes. The technology is generally individually tailored to collaborator needs.

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